# The Cause and Prevention of Mould in Canadian Pasteurized Butter



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## DAIRY AND COLD STORAGE

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# CONTENTS



94613—1

# THE CAUSE AND PREVENTION OF MOULD IN CANADIAN PASTEURIZED BUTTER

## Introduction

While no data are available as to the actual financial losses suffered, statements from men in contact with the trade and from dealers in the United Kingdom show that mould in Canadian storage butter is now of serious economic importance. To the maker who receives a cut of several cents per pound because of mould, the monetary side of the question looms large. No matter how large or how small the loss, it is a needless one and one we can and must prevent.

As a result of the damaging effect of mould in the export trade, a full investigation of the trouble was made. The work reported has extended over a considerable period and numerous creameries and consignments of butter were examined to determine the cause of mouldiness in butter, so that suitable recommendations for its prevention could be made.

Scientific investigations show that there are two possible methods by which mould may be prevented from developing in butter:—

1. By preventing the entrance of mould or their spores to the butter during the manufacturing process.
2. By preventing their development by low temperature after they have gained entrance.

The phase of the work here reported deals with the former method, that is, preventing their entrance during the manufacturing process. It is needless to say that, once moulds have gained entrance to the butter, mould development cannot be completely controlled where butter is subject to a wide range of temperature, as so happens in our retail and export trade.

Data are now available to show that the control of mould is a problem that can be solved only by the creamery operator. Mould in Canadian pasteurized butter can be attributed largely to recontamination of the pasteurized cream through coming in contact with insanitary equipment, as holding vats, conductor pipes, pumps, outlet valves, churns, impure water and untreated liners.

The present report is intended to give practical suggestions and to be of assistance to the average creamery operator in combating mould in butter.

## Some Opinions of the English Butter Market

In order to emphasize the importance of the mould question to the creamerymen, some opinions of members of the trade are given. A few extracts from these letters show the feeling of the trade in England and the seriousness of the condition during the seasons of 1923 and 1924.

"There is still a tendency of Canadian butter to mould, and a great advantage I think would be for any unsalted butter for export to have a small amount of preservative therein, which would assist greatly in the keeping quality of the butter."

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"There has been quite a lot of talk over here this year that Canadian butter, particularly western Canadian butter is subject to mould. We have done our best to contradict these statements where we have heard them, and we think far too much importance and too much talk has been made on this point on this side."

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"Saskatchewan certainly had a good reputation last year (1922), and I have heard a good many favourable comments within the last six weeks, but the mould has undone a great deal of the good work."

"While butter has been held in storage, awaiting better markets, the mould has developed and our goods have suffered from two angles, namely, mould and poor keeping properties."

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"I am not in a position to report definitely, but I should not be surprised if there is not a general impression with a large section of the trade that Canadian butter, and probably more particularly Western Canada butter, is subject to mould."

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"I examined this parcel this morning. Sixteen boxes of First Grade were turned out and 6 boxes of Second Grade. The red, blue and black mould showed on all the 16 boxes of Firsts and in most cases over the entire surface, top, bottom and sides. The Second Grade butter was not so badly moulded, but was showing.

"The buyer turned out every box in this lot of 400. There were 364 Firsts and 140 were mouldy. There were 36 Seconds and 9 showed mouldy."

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"I examined yesterday 19 churnings out of 48 shipped, and I report as follows:—

Churning No. 168—Mouldy. Flavour slightly stale. Doubtful first.
" " 174—Mouldy flavour. Quite stale. Second grade.
" " 319—Slightly mouldy.
" " 233—Slightly mouldy.
" " 315—Mouldy.
" " 320—Very mouldy.
" " 329—Mouldy.
" " 332—Very mouldy.
" " 177—Mouldy.
" " 180—Mouldy.

"Ten out of nineteen boxes were mouldy."

## What are Moulds?

"Mould" is a term applied to a large group of very small plants. They differ from the common plants with which we are familiar in everyday life in that they possess no green colouring matter by which the higher plants utilize the sun's rays in building up their tissues. Hence they live as well or better in darkness than in light.

## Distribution of Moulds

Mould growths and their spores or seeds are widely distributed and are to be found on or in practically every material associated with the manufacture of butter. They are to be found in enormous numbers in unpasteurized cream, in improperly cleaned equipment, as pipes, pumps, holding vats, cans and churns. Since they grow upon decaying wood or moist surfaces, wooden walls and ceilings of the factory and cold storage may harbour millions of these little plants. Investigation has shown that storage of boxes, parchment and salt in damp and poorly ventilated rooms may be a factor in disseminating the young plants and their seeds. Since the seeds of the mould plant are not discernible to the naked eye, their distribution cannot be determined by the creamery man, and only by suitable laboratory tests can we tell their movement. It should also be remembered that mould spores or seeds are exceedingly small and light and are carried through the factory not only by unclean equipment but by currents of air.

## Requirements for Mould Growth

Since moulds are plants, they obey certain fixed laws and, like the higher plants, require for their growth moisture, oxygen or air, a suitable temperature and a supply of food.

For mould growth, a certain amount of moisture is necessary. This requirement is found in butter, in that it contains from 14 to 16 per cent. Where moisture is poorly incorporated or where leaky butter is manufactured, moulds find optimum conditions for growth.

Moulds, like higher plants, live only where a supply of oxygen or air is to be found. Where butter shrinks from the sides of the boxes through the loss of water, these spaces become filled with air and supply a suitable condition for mould growth, other factors being equal.

While a certain amount of heat is essential to the growth of moulds, there is a wide range of temperatures under which growth is possible. Many of the moulds grow most rapidly at body temperature, but continue to grow slowly at temperatures approaching the freezing point. Other varieties find the most favourable conditions at lower temperatures and grow with comparative rapidity in ordinary refrigerators.

Thom and Hunter, of the United States Department of Agriculture, showed that when a series of moulds were subjected to temperatures approaching the freezing point, it was found that many species grew slowly and produced no coloured spores, but colourless growths were detected. These observations taken together may account for many reports in which a butter, passed as sound when removed from storage, became recognizably mouldy (i.e. developed coloured areas) remarkably quickly at household temperatures. Laboratory examination in such cases would doubtless have shown well-established growths in the product as it came from the refrigerator.

Almost any animal or vegetable matter serves them as food, and we find them growing readily on bread, meat, leather, green wood of butter boxes, wooden ceilings and walls of creameries, creamery equipment, as churns, pipes, pumps, vats, etc. Here they find a sufficient supply of food as they are able to utilize the casein, fat and other constituents of milk and cream that adhere to the factory equipment. Their growth in butter may be attributed to the fact that they can use as food, the curd, fat and acids of the butter. Where moisture, temperature and air are available, butter parchments serve as food for moulds.

## Reproduction or Propagation of Moulds

Moulds reproduce themselves by spores which correspond to the seeds of higher plants. Under favourable conditions, each plant may produce millions of seeds, which on germination grow into plants which again produce seeds, and so on. The spores or seeds of some of the moulds occurring commonly on butter are often coloured brown, black and green, so that when produced in large numbers impart to the surface of butter and liners varying intensities of colour.

## Destruction of Moulds

Mould plants are easily destroyed, but their spores or seeds are somewhat more resistant on account of their peculiar structure. Spores may be dried for years and yet under favourable conditions they will germinate and in a surprisingly short time produce a plant bearing millions of seeds. Investigations have shown that few moulds or their spores in milk survive a temperature of 140° F. for thirty minutes and still less are able to withstand 145° F. for thirty minutes. The writers found that under commercial conditions of pasteurization 100 per cent of the moulds were killed in cream at 185° F. for ten minutes. Very short exposures to boiling water gave similar results.

Short exposures to disinfectants destroy the spores or seeds, but moulds readily adapt themselves to unfavourable conditions and are frequently found growing in the presence of antiseptics. In the light of this it would seem then, that the most effective and surest way of destroying the mould and its spores is by the use of hot water and steam, as they succumb rapidly at 185° F. or above in a few minutes.

94613—2½

## What are Yeasts?

A second type of plant life, which is a common inhabitant of the creamery and with which all creamerymen should be familiar, is the yeast plant. During the summer months every creamery receives from the producer cans of foamy cream. This foam is caused by the presence of large numbers of yeast plants, which act upon the constituents of the cream, giving rise to gas, froth and foaming of the cream.

## Distribution of Yeasts

Like moulds, yeasts are widely distributed and are to be found on or in practically every material associated with the manufacture of butter. They are to be found in enormous numbers in unpasteurized cream, in improperly cleaned equipment, as pipes, pumps, holding vats, cans and churns.

## Requirements for Yeast Growth

Yeasts, like moulds, require for their growth a suitable supply of moisture, oxygen, food and a favourable temperature. Under factory conditions, we find yeasts and moulds intimately associated and growing under similar conditions.

## Reproduction or Propagation of Yeasts

Unlike moulds, this group of plants is microscopic in size. While varying somewhat, an average size is about $\frac{1}{4000}$ of an inch in diameter. They are usually spherical or oval in shape, though sometimes slightly elongated. Unlike moulds, they do not have a root system, so they cannot force their way into hard substances. Their chief characteristic is their method of reproduction by a process of budding. There appears on the side of the yeast cell a minute bud, which continues to increase in size until it becomes as large as the cell from which it has grown. Then the two cells may break apart at once; or each may produce buds before they separate. This budding takes place rapidly under favourable conditions, giving rise to numerous new yeast plants.

## Destruction of Yeasts

Yeast plants, like moulds, are easily destroyed, succumbing to lower temperatures than are necessary for the destruction of mould spores. The writers found that with commercial methods of pasteurization, 100 per cent of the yeasts were killed at 185° F. for ten minutes. Other investigations have demonstrated that most yeasts are destroyed at a temperature of 141·8° F.

## Description of Mould on Butter and Parchment

Butter infected with mould develops varied colour areas on its surface when subjected to conditions and temperatures suitable to mould growth. These areas vary in colour from black, dirty green, green, orange yellow and brown.

These mould growths generally appear first on the surface but in advanced cases may penetrate the butter to the depth of one-half to three-quarters of an inch. Apart from the unsightly appearance of mould, butter of this character develops off flavours resulting in a low-grade product.

Mould growths on parchments appear as greenish brown to black smudged areas, depending upon the degree of development.

In many instances moulds appear on both parchments and butter, while again only the parchment or the butter may show infection.

Figure 1, Plate 1, shows two 14-pound boxes of butter badly infected with surface mould and presents types of discoloration as previously described. Figure 2, Plate 1, shows parchments spotted with mould areas.

PLATE I

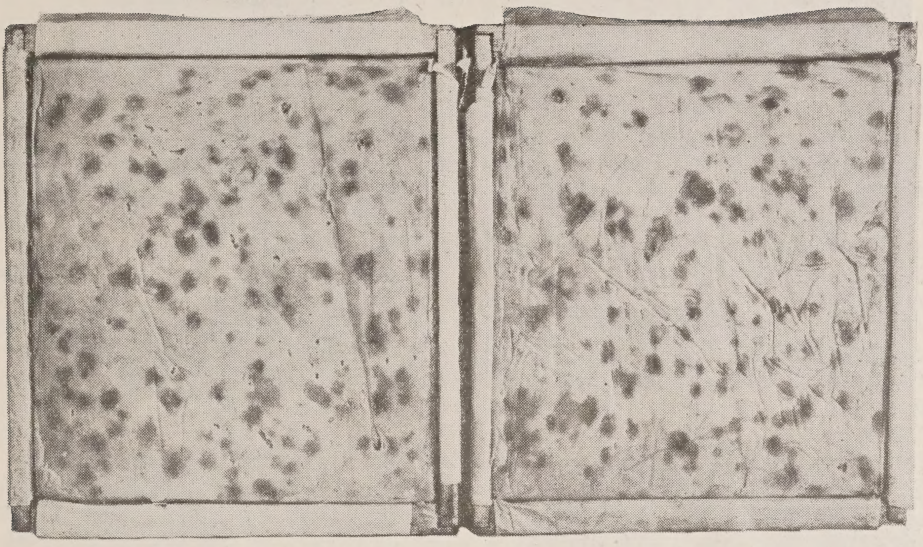


FIG. 1.—Boxes of pasteurized butter showing badly moulded surfaces.

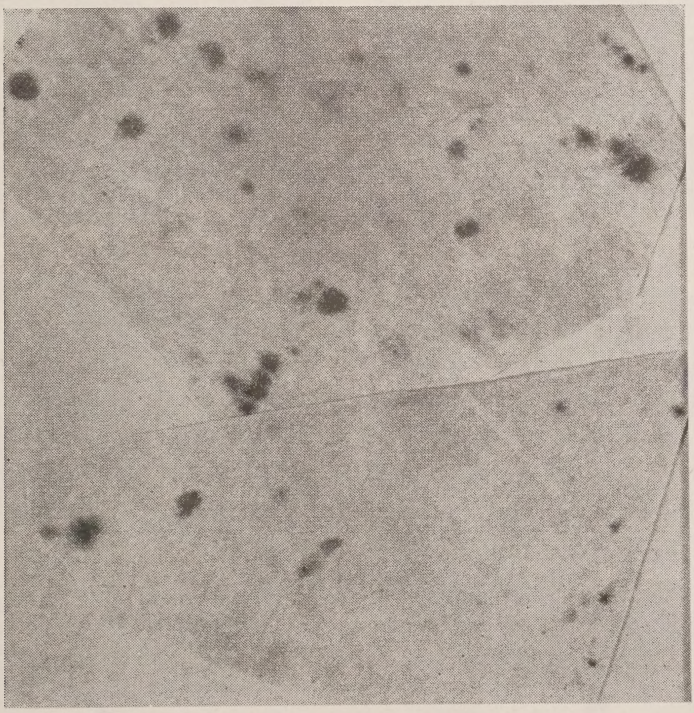
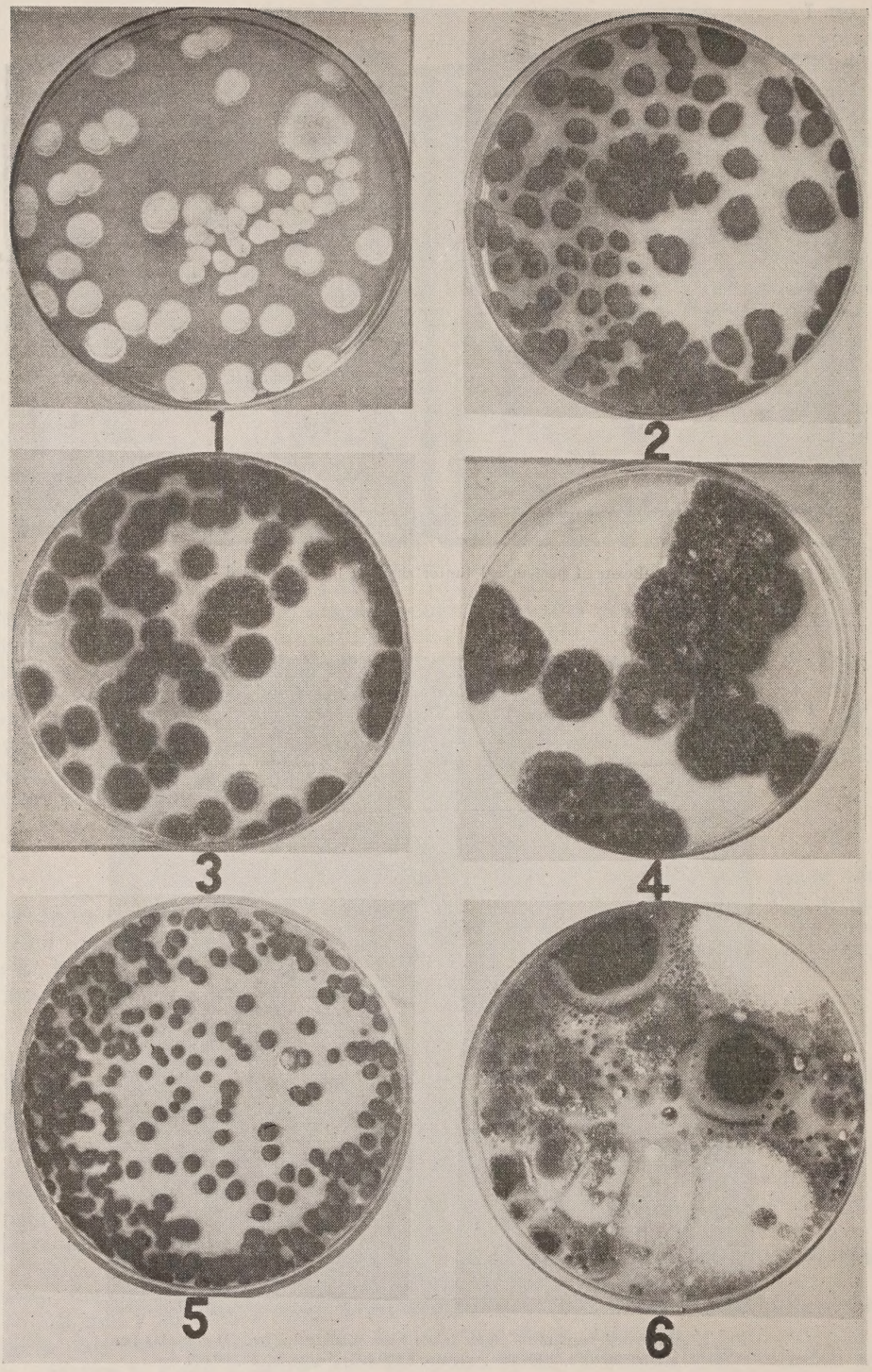


FIG. 2.—Untreated parchment paper taken from mouldy butter. It contains per gram: moulds, 1,850,000; yeasts, 6,000,000; bacteria, 30,000,000.

PLATE II




FIGS. 1-6.—Some common types of moulds from pasteurized butter.

## Sources of Mould in Creameries

Considerable has already been said about mould growths in general. In addition to this, the attention of the creameryman should be drawn to conditions about his own factory as the probable and possible sources of contamination.

In practice, cream as delivered to the factory is usually heavily infected with moulds, depending, of course, somewhat on the age of the cream, although no trace of mould is discernible upon the surface of the cream. When cream is efficiently pasteurized, the living mould plants and spores are destroyed, so that subsequent development and trouble most naturally come from conditions surrounding the cream.

Assuming that pasteurization is 100 per cent efficient and all moulds and spores are destroyed, it lies with the creamery man to protect the pasteurized cream from reinfection, while it is held in the factory, preparatory to churning it into butter.

As already intimated, wood is one of the principal fields for production of mould found in factory butter, and it is interesting to note how closely the pasteurized cream and the butter are brought into contact with this highly probable source of infection.

Customarily, the cream after pasteurization is held in a vat which stands in a room with walls and ceilings made of wood. From the vat the cream passes into a churn which is constructed principally of wood. Usually the walls and ceilings of the churn rooms are of wood, and the butter churned from the cream is packed into a wooden box. Additionally, a number of factories burn wood fuel, and frequently many cords of firewood are stacked in close proximity to the factory, while stacks of butter boxes are common in all factories.

In all the factories studied, and in a very high percentage of the commercial plants, moulds were found associated with cream pumps and piping used for the conveyance of cream from place to place in the factory. Sanitary piping is still lacking in some plants, and serious recontamination is not uncommon by passing unpasteurized and pasteurized cream through the same pipes without thorough cleaning.

Mould growths are frequently attached to the surface of unseasoned box timber, and boxes which have been moistened during transit are very liable to cause trouble. Too great care cannot be given to the protection of the boxes from moisture. The writers have observed boxes set and packed on a wet floor, and half boxes from previous churnings left on the factory floors during the day's washing up and over night. Boxes properly paraffined are a great aid in preventing mould, but the process is not perfect and occasionally one sees boxes with little or no adhering paraffin. Boxes showing the presence of mould assist in aiding the trouble.

Butter parchments and salt may be the means of infecting butter. Investigation shows that parchments may be contaminated when received by the creamery men, but usually the trouble arises from the exposure of the parchment in a damp and dirty room at the factory.

Water supplies, holding tanks and ice may frequently cause considerable reinfection.

The neglected wood-pile provides a prolific source for seeding the atmosphere bordering the factory with mould-producing organisms. These spores may be carried by air currents through adjoining doors and windows.

## Relation of Salt Content in Butter to Mould Development

While salt in high concentrations has a preventive effect on mould growth, the percentage of salt used in our export butter gives a concentration too low to inhibit mould growth, but may be a factor in retarding their development.

The export trade demands a low salted butter containing in the neighborhood of about 1.5 per cent of salt, giving a brine concentration of approxi-

mately 8.5 per cent. In an extensive investigation conducted by Thom, of the United States Department of Agriculture, he pointed out that 2.5 per cent salt giving a brine concentration of 15 per cent was necessary to inhibit certain forms of mould growth, but even with this high concentration some still developed.

Experimental pasteurized butter of the export type having a high mould and yeast count developed mould readily when subjected to optimum temperatures, showing that the salt concentration common to our export butter was not a factor in preventing mould growth.

### Preservatives

Many chemical substances, when added to butter, retard the growth of mould and other micro-organisms; such substances are called preservatives. The chief among these are boric or boracic acid, salicylic acid, saltpeter and formaldehyde; the first mentioned is the most commonly used.

The trend of opinion among pure food authorities of to-day, is for the elimination of chemical preservatives and many importing countries are now prohibiting butter containing such substances.

The two chief objections to their addition to butter are:—That they may be, and doubtless are, relied on to protect those engaged in the trade against immediate results of neglect of scrupulous cleanliness, and because they are injurious to the health of the consumer.

The writers are of the opinion that it is not necessary to use preservatives to control mould, as this trouble can be overcome by thorough pasteurization, cleanliness in manufacture, and above all, sterilization of all equipment.

### Method of Making Mould and Yeast Counts in Butter

Under previous headings a description is given of some of the common butter moulds and yeasts, including their habits, methods of growth, reproduction, etc. Since these organisms are common inhabitants of butter, it is important to know to what extent they may be present. This is done by counting and is known as "The Mould and Yeast Count of Butter." The method is as follows:—

Samples for mould and yeast counts may be taken direct from the churn or better at the grading station, or at the cold storage where the scoring has been done, from the boxes of freshly made butter. Two four-inch plugs are drawn with sterile cheese triers and the lower three inches of each transferred to a sterile 60 c.c. glass bottle by means of the handle of a sterile teaspoon, and top screwed on. When sampling is done in the above manner, it will be seen that surface contaminating organisms are avoided, the examination being made on butter taken from the interior of the package. This procedure is obvious as the butter taken from the surface layer may be heavily contaminated with mould from the use of untreated liners, while the butter in the interior of the package may be free from them. After the samples are secured they are refrigerated and taken to the laboratory.

The laboratory method of examination is to melt the butter at 110° F. and thoroughly mix; 1 c.c. samples are withdrawn and placed in suitable glass dishes to which a food material is added. The dishes are then kept at a temperature of 68° F. for five days. By this time the mould spores and yeasts have grown and are visible to the naked eye, so that they may be counted and recorded as the number of moulds and yeasts per c.c. of butter. In cases where the mould and yeast count is high, the butter must be diluted with water to make the count possible.

## Mould and Yeast Standards for Pasteurized Butter

As an aid in controlling mould in butter, no test has been found so valuable and so full of information as the mould and yeast count, as it furnishes a dependable check on the efficiency of pasteurization and the sterilization of the equipment. For these reasons, systematic mould and yeast counts should become a routine test for the man who is storing or exporting butter.

F. W. Bouska, of the Beatrice Creamery, Chicago, has set an arbitrary standard of 30 as the maximum count of yeasts and moulds per c.c. of butter which has been made from efficiently pasteurized and handled cream. Where special care has been taken during the manufacturing process, he states that a large percentage of the counts should be 10 per c.c. or less. While the writers endorse this, the following standards are recommended:—

Total moulds and yeasts: below 10 per c.c.—Excellent.
Total moulds and yeasts: 10-50 per c.c.—Good.
Total moulds and yeasts: 50-100 per c.c.—Fair.
Total moulds and yeasts: over 100 per c.c.—Poor.

We have found that with commercial methods of manufacture, it was possible to keep consistently below a total of 50 per c.c., which is classified as good workmanship.

If high yeast and mould counts persist, the laboratory reporting such counts should be called upon to assist in locating the source of the trouble. A laboratory analysis of the cream after each operation will assist the operator in finding where recontamination takes place, and show when these sources have been cleaned up.

## Mould and Yeast Counts as an Index to Mouldy Butter

Table I is a comparison of an efficiently and an inefficiently operated creamery as judged by the mould and yeast count of the finished butter.

TABLE I

| Creamery A. Classification—Poor | | | | Creamery B. Classification—Very Good | | | |
|---|---|---|---|---|---|---|---|
| Pasteurized Butter Sample | Moulds per c.c. | Yeasts per c.c. | Bacteria per c.c. | Pasteurized Butter Sample | Moulds per c.c. | Yeasts per c.c. | Bacteria per c.c. |
| 1 | 22 | 6,700 | 4,000,000 | 1 | 2 | 13 | 7,700 |
| 2 | 30 | 3,600 | 5,400,000 | 2 | 1 | 18 | 7,900 |
| 3 | 50 | 9,300 | 6,000,000 | 3 | 0 | 16 | 3,200 |
| 4 | 16 | 7,000 | 4,160,000 | 4 | 2 | 15 | 4,400 |
| 5 | 20 | 1,900 | 2,580,000 | 5 | 0 | 28 | 3,800 |
| 6 | 10 | 26,400 | 160,000 | 6 | 0 | 7 | 800 |
| 7 | 200 | 100,000 | 7,600,000 | 7 | 0 | 14 | 12,800 |
| Total average of yeasts and moulds—9,321 | | | | Total average of yeasts and moulds—17 | | | |

In comparing creameries A. and B., it will be noted that the total average of moulds and yeasts in the butter was 9,321 in creamery A., while in B. the total average was only 17. In factory A. considerable trouble was experienced throughout the summer months with mouldy butter, while in factory B. no trouble with mould occurred.

The above figures indicate that where pasteurized butter contains, through recontamination and inefficient pasteurization, a high mould and yeast count, trouble with mouldy butter occurs consistently at some point before consumption, whereas in the case of creamery B., butter was free or very low in moulds and yeasts, and no trouble was experienced.

We conclude, therefore, that with proper care in manufacturing operations as to cleanliness and efficient workmanship, pasteurized butter should not exceed a total of 50 yeasts and moulds per c.c. of butter, and where these conditions obtain, mould on butter has not occurred.

### Mould and Yeast Counts of Pasteurized Mouldy Butter

Table II shows the mould, yeast and bacteria counts of samples of pasteurized butter in 56-pound boxes showing surface mould on butter.

TABLE II

| Pasteurized Butter Sample | —— | Moulds per c.c. | Yeasts per c.c. | Bacteria per c.c. |
|---|---|---|---|---|
| 1 | Unsalted | 140 | 14,400 | 8,800,000 |
| 2 | " | 4,000 | 24,000 | 6,000,000 |
| 3 | " | 5,600 | 19,200 | 16,000,000 |
| 4 | " | 3,600 | 12,800 | 12,000,000 |
| 5 | Salted | 600 | 100,000 | 3,200,000 |
| 6 | " | 780 | 100,000 | 3,500,000 |
| 7 | " | 2,000 | 100,000 | 12,000,000 |
| 8 | " | 100 | 100,000 | 2,300,000 |

The above figures show that the interior of the butter contained high numbers of moulds and yeasts, indicating serious recontamination, resulting in surface mould development.

In Table III are to be found the results of an examination of a 56-pound box of pasteurized butter showing surface mould on the butter and badly discoloured parchment.

TABLE III

| —— | Moulds per c.c. | Yeasts per c.c. | Bacteria per c.c. |
|---|---|---|---|
| Parchment | 1,850,000 | 6,000,000 | 30,000,000 |
| Interior of butter | 200 | 100,000 | 7,600,000 |
| Surface of butter | 4,200 | 160,000 | 24,000,000 |

From these figures it can be seen that the parchment liners were not treated, and that the butter as manufactured contained a high number of moulds and yeasts, again indicating serious recontamination.

### A Comparison of Pasteurized and Unpasteurized Butter

In Table IV are given the mould, yeast and bacteria counts of five pasteurized and nine unpasteurized samples of butter.

TABLE IV

| Sample | Moulds per c.c. | Yeasts per c.c. | Bacteria per c.c. | Storch Test |
|---|---|---|---|---|
| 1 | 60 | 70,000 | 250,000 | Unpasteurized |
| 2 | 70 | 500,000 | 110,000 | " |
| 3 | 23 | 20,000 | 27,600 | Pasteurized |
| 4 | 80 | 20,000 | 400,000 | Unpasteurized |
| 5 | 92 | 200,000 | 5,380,000 | Pasteurized |
| 6 | 50 | 500,000 | 810,000 | " |
| 7 | 200 | 200,000 | 120,000 | Unpasteurized |
| 8 | 60 | 10,000 | 170,000 | " |
| 9 | 520 | 300,000 | 250,000 | " |
| 10 | 70 | 8,800 | 150,000 | " |
| 11 | 47 | 25,000 | 1,610,000 | Pasteurized |
| 12 | 32 | 12,840 | 490,000 | Unpasteurized |
| 13 | 20 | 8,000 | 370,000 | " |
| 14 | 120 | 100,000 | 4,060,000 | Pasteurized |

In comparing the above mould and yeast counts, there appears to be no appreciable difference in pasteurized and unpasteurized butter. This is explained by the fact that pasteurized cream is so seriously recontaminated during the process of manufacture that the good effects of pasteurization are offset in so far as it controls yeasts, moulds and undesirable types of bacteria, and where such workmanship is followed, mouldy butter will appear, especially during the warmer months of the season.

Charts I and II, pages 14 and 15, illustrate the most possible sources of recontamination as found in the average creamery.

The figures show that the bulk of the raw cream received at creameries contain large numbers of yeasts, moulds and bacteria. However, after pasteurization at 180° F. for ten minutes, all yeasts and moulds and 99·9 per cent of the bacteria were destroyed.

In both creameries, the cream was held overnight before churning, and when held in the same vat as pasteurized, there was no increase in the yeast and mould content, although there was a slight increase in bacteria, due to the growth of the organisms remaining after pasteurization. When the cream was transferred to another holding vat there was some recontamination from the pipes, pumps and the holding vat itself, as was the case in Creamery A. Pipes and pumps are a source of recontamination, as is shown by the yeast and mould count on the pasteurized cream after it has passed through this equipment on its way to the churn.

The churn is, undoubtedly, the most troublesome source of recontamination due to the difficulty of keeping the wood thoroughly clean and in good condition. In Creamery B., where the churn was comparatively new and fairly easy to clean, and where liming took place at frequent intervals, recontamination was not serious. But in Creamery A. the churn was old, the wood was worn and rough, and no liming treatment was used. In this case, there were considerable numbers of yeasts, moulds and bacteria picked up during the churning process, as evidenced in the counts on the buttermilk.

The data also show the possibility of infection by the parchment liners where no special treatment was practised. In Creamery B. the liners were treated by boiling in a brine solution, which destroyed all yeasts and moulds. But in Creamery A. the liners were not treated and showed quite a high count for both yeasts and moulds.

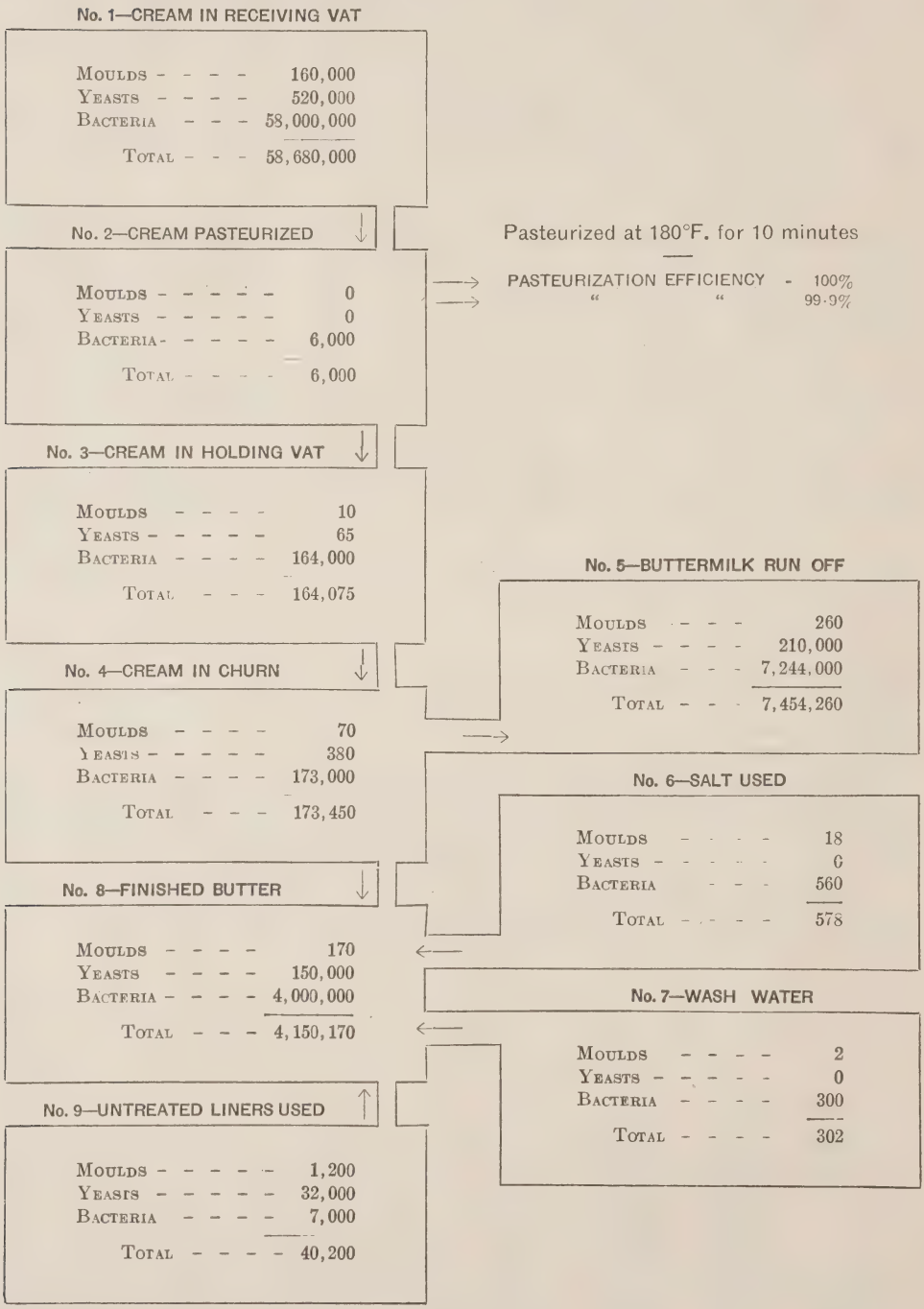
Salt may also be a source of recontamination when it has not been properly stored. The sample of salt from Creamery A. contained 18 moulds per gramme. Even when the butter contains a low percentage of salt, large numbers of moulds may be incorporated in the butter in this way.

It should be clearly understood by the creameryman at this point, that *if mould is kept out of butter* during manufacture after pasteurization, later trouble cannot occur during refrigeration and transportation.

*Chart I*

BACTERIOLOGICAL SURVEY SHOWING SOURCES OF RECONTAMINATION IN CREAMERY A., AUGUST 4 AND 5, 1924

*Classification—Poor*

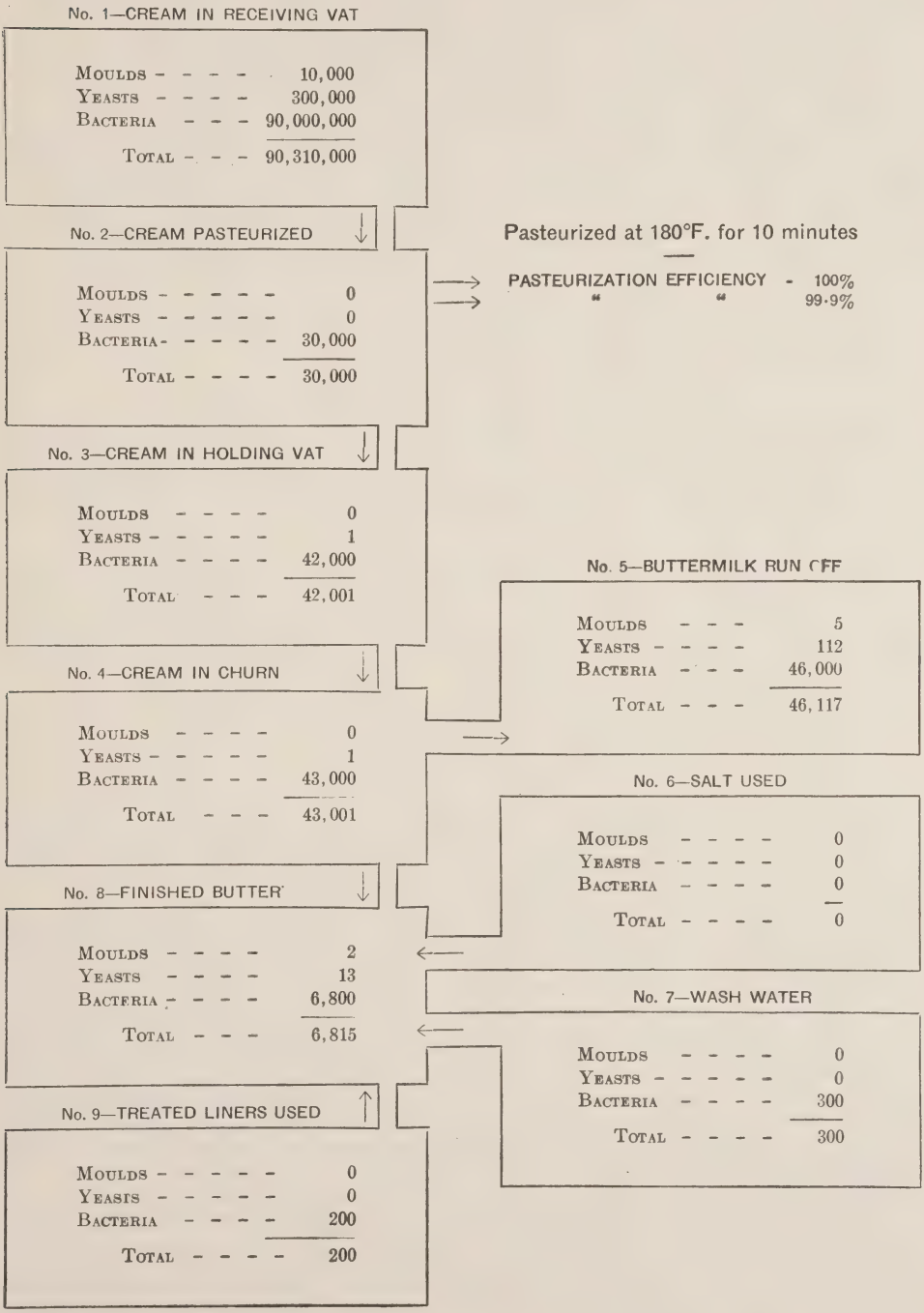



N.B.—Above figures are on a cubic centimetre basis.

*Chart II*

BACTERIOLOGICAL SURVEY SHOWING SOURCES OF RECONTAMINATION IN CREAMERY B., AUGUST 11 AND 12, 1924

*Classification—Very Good*




N.B.—Above figures are on a cubic centimetre basis.

## Parchment Liners

During the past few years there has been a feeling among creamery men, that the parchment supplied was in some way responsible for mould on butter. To verify the above, the following statement by Mr. C. G. Stuart, of Henderson-Stuart, Limited, from the 1924 Report of the Canadian Produce Association, is given: "In this connection I understand that some of our Canadian creameries have been dissatisfied with the quality of the parchment that they are able to buy in Canada, and they are taking steps to obtain a supply of superior parchment from Denmark and Sweden."

To determine the relation of parchment to mouldy butter, samples were obtained from all possible sources, including Canada, United States, United Kingdom and European countries. Laboratory investigations showed that all of the samples were true parchment, and that mould was found on all, and no one parchment was superior from the standpoint of mould development. To prevent mould on parchment, irrespective of its source, thorough treatment must be practised as outlined below.

To give sufficient protection for export trade, we recommend a parchment liner of not less than 40-pound weight.

## Metallic or Black Specks on Parchment

Speaking with a number of creamery men, their chief concern regarding parchment is not so much the quality but the presence of minute iron and copper particles embedded in the paper. These specks at times produce greenish discoloured spots on the butter through the action of the acid and salt on the metals.

These metallic specks find their way into the parchment from metal buckles and buttons adhering to the rags used in the manufacture of paper. At present, we have no guarantee that parchments do not contain these specks, but every effort is being made on the part of the manufacturers to eliminate this defect.

While these metallic discolourations somewhat resemble some forms of mould growths, the two should not be confused.

## Treating Parchment Liners

Parchment liners should be properly stored, thoroughly treated before using, and be of suitable weight. All liners should be stored in a clean, dry place, in the original package until used. A paper of 40-pound weight or over is recommended for lining 56-pound boxes. Treatment:—

Make up in a wooden or fibre tub, a brine solution in the proportions of 1 gallon of water to 4 or 5 pounds salt. Sufficient of this solution should be used to completely cover the liners. Count out from the original package sufficient liners for the following day's make and place loosely in the brine solution, so that the heat will penetrate to every liner. Bring brine solution to the boiling point by the use of steam, and continue boiling for five minutes. During the heating period, see that all liners are submerged in the salt solution. Place a suitable cover over the tub and allow liners to remain in brine solution until next day. This will expose them for a considerable time to the necessary heat to destroy all yeasts and moulds, and they will be cool, ready for use on the following day.

Brine may be repeatedly used, but should be kept up to full strength, and changed every seven or ten days.

Formaldehyde solutions have been successfully used for the treatment of parchment liners. It is most important, however, that such solutions be of proper and maintained strength, and this is often neglected in the average creamery. Carelessness or neglect in use, results in weak solutions which are

ineffective in destroying mould, and at the same time, giving a false sense of security to the buttermaker. Formaldehyde solutions deteriorate rapidly, leaving the buttermaker with no way of determining their strength. However, he can always be sure of having a boiling brine solution, and for this reason, such treatment for liners is recommended.

## Care of Creamery Refrigerators

It is still a common belief among creamery men that the primary factor in mouldy butter is due to mould in refrigerators, but from the nature of the package, it is very improbable that the inside of the box could become contaminated after it is filled. Temperature and moisture conditions favouring mould growth on the walls of the refrigerator also favour mould growth on the butter, but the infection comes from the butter and not from the refrigerator. However, refrigerators must be clean, dry, well ventilated, and disinfected to prevent the growth of moulds, and their distribution throughout the creamery. For disinfecting and to keep clean, one of the cheapest and most practical methods is that of whitewashing. While it may appear simple to prepare and apply whitewash, many have not yet acquired the art; for this reason, Cooper's method, taken from Practical Cold Storage, is given in detail. The method is as follows: Take one-half bushel of lime and place it in a half barrel (an oil barrel or vinegar barrel which has been cut down makes a good utensil for this purpose); pour on a small quantity of boiling water, barely sufficient to cover the lumps of lime; keep the lime well stirred clear to the bottom (a piece of one-inch gas pipe about five or six feet long is the best stirring stick). In case the lime is very quick, it should require two persons to slake the lime, one to pour on the water as needed and one to stir. The stirring should be kept up continuously from the time the lime begins to slake until it is reduced to a paste, and water should be added as fast as the lime slakes, so as to keep it a rather thin, pasty consistency. It is very common to see lime placed in a barrel and water turned on and the lime allowed to slake itself. The result is that the whitewash is full of small pieces or lumps which are not slaked, but are burned as the result of water not coming in contact with the lime at the right time. It is not absolutely necessary that boiling water should be used, but unless the lime is quite quick, it facilitates the operation and results in more thorough slaking. When the lime is thoroughly slaked, add one-half peck of salt. It will be necessary to add more water as the salt is added, in order to keep the whitewash at the proper consistency; or the salt may be dissolved separately in as small an amount of hot water as will absorb it readily. The proper consistency for whitewash is a thin paste and it may be tempered as it is used. To each twelve-quart pail of whitewash, composed of lime and salt as above, add a good, fair handful of Portland cement and about a teaspoonful of ultra-marine blue. The cement and blue should be added only as the wash is being used and should be thoroughly stirred in the whitewash; otherwise, when applied, it will be streaked. Cement is used for the purpose of giving the whitewash a better setting property, so as to make it adhere better to the surface to which it is applied. The ultramarine blue is used simply to counteract the brownish colour of the Portland cement. The wash should be strained through a fine wire-cloth strainer before using, to remove the lumps if there are any present. Directions for application: The surface to be treated should be perfectly dry, and carefully cleaned of all dirt, scales or other loose material, by brushing well with a clean stiff brush. Apply with an ordinary whitewash brush. Do not put on too thick a coat; just enough to cover the surface. Allow one to three days for drying.

Refrigerators should be whitewashed every six months, or oftener if possible.

## Cleaning Equipment

One of the most important factors in the contamination of creamery butter with yeasts and moulds, is improperly cleaned equipment. It is not sufficient that vats, pumps, pipes and churns be clean to the eye; they must be as clean bacteriologically and as sterile as it is possible to make them. This can readily be done by a liberal and intelligent use of boiling hot water or live steam.

Cream vats should be first rinsed with warm water, then thoroughly washed every day with a hot solution of alkali washing powder, using a brush to remove all particles of curd and grease. After rinsing in hot water, vats should be steamed for at least five minutes. A simple method is to close the vat covers and introduce the steam into the vat through the outlet gate. This will heat the vat to a temperature of 180° F. or higher, which will insure the destruction of all yeasts, moulds and their spores. After five or ten minutes, open the lids of the vat, and the heat will cause a rapid evaporation of the moisture, leaving the vat in a dry condition.

Pumps and pipes for the conveyance of cream should be so constructed and placed, that they can be taken apart and thoroughly cleaned every day. Pipes should be cleaned with a brush to remove all particles of cream that may be lodged in them. After a thorough washing in a hot solution of washing powder and rinsing in hot water, pipes and pumps should be steamed for about five minutes.

The churn, is, undoubtedly, the most dfficult piece of equipment to keep clean, due to the material and type of construction. However, it is possible to keep a churn in such a condition that butter will contain a total of less than 50 yeasts and moulds. The following method of washing a churn that is in daily use, has been found to give good results and is recommended.

1. Rinse the churn well with clean hot water to remove the butter still sticking to it.
2. Then thoroughly wash with a hot solution of alkali washing powder, using 2 or 3 pounds to churn about one-quarter filled. The water during this washing should be brought to the boiling point by putting the steam hose directly in the churn. Revolve the churn in high gear for five to ten minutes.
3. Drain, and rinse well again with boiling water, revolving the churn at high gear for five or ten minutes.
4. Drain thoroughly, and turn the churn with the doors up and open. The churn will quickly dry after this last rinsing in boiling water.
5. Before using, it is recommended that churns be steamed or rinsed first with hot water at least 180° F., and then rinsed and cooled with cold water.
6. Churns should also be limed at least once a week.

Lund, of the Ontario Agricultural College, gives the following method of liming a yeast and mould infected churn, and was able to reduce the counts in butter to less than 10 per c.c.:—

"Secure a few lumps (3 to 5 pounds) of fresh unslaked lime and slake by adding small quantities of hot water from time to time. When slaked, add sufficient hot water to make up to 10 gallons or so. Mix well and pour into the churn. Turn steam hose into this milk of lime mixture and bring to the boil. Close churn doors and revolve for fifteen minutes, five minutes at high speed, and ten minutes at low speed with worker rollers in gear. Stop churn and bring milk of lime mixture to the boil again. Revolve fifteen minutes more as above. Do not dump out lime mixture, but turn churn doors to the top and fill to the brim with cold water. Allow churn to stand full of this lime water until required for use again. Empty out lime water and wash out thoroughly with two changes of cold water."

It is advisable to strain the lime solution before putting it in the churn. This will prevent any large particles of lime becoming lodged in the churn and later picked up in the working of the butter.

Liming the churn tends to harden the wood, fills up the pores, excluding curd and grease, and keeps it in a clean, sweet-smelling condition.

New churns or churns that have been standing idle for some time should receive special care before using. They should be washed with a hot solution of good washing powder, and then treated and soaked for two or three days in a milk of lime solution prepared in the same manner as that recommended above.

When churns have become sticky, due to the pores of the wood becoming clogged with grease and curdy particles, it is necessary to use some chemical to remove this material from the wood. After a thorough washing in the ordinary way, we recommend that such churns be treated for at least half an hour with a dilute solution of sulphuric acid, using about 1 pint of commercial sulphuric acid to 50 gallons of water. After treatment with this dilute acid solution, the churn should be rinsed thoroughly several times with hot water.

The wooden butter ladles and pounder should also be thoroughly washed and then scalded with boiling water after use. Before using again, they should be soaked in boiling water and then cooled with clean, cold water.

It is also advisable to have screens or covers made for the doors of the churn to keep out flies and dust while the churn is standing idle. A simple wooden frame, covered with light cotton, can easily be made to fit the churn doors, and at a minimum of expense.

### Recommendations for the Prevention of Mould in Butter

Mouldiness in butter may be prevented by observing the following precautions:—

1. Pasteurize all cream. The method now employed of heating the cream to such a temperature that the butter will give a negative reaction to the Storch Test, is recommended. This temperature will be at least 170° F. for ten minutes. When using the holding process, draw off a pailful of cream from the outlet gate as soon as the cream reaches the maximum temperature of pasteurization and pour it back into the vat. This insures proper pasteurization of the plug of cream in the outlet gate and eliminates the possibility of recontamination from unpasteurized cream.

2. Thoroughly cleanse all vats, pipes, conduits, pumps and churns daily. (See under Cleaning Equipment.)

3. Parchment papers should be thoroughly treated in a hot brine solution. (See under Treatment of Parchments.)

4. Boxes should be stored in a clean, dry place. Purchase only boxes that are properly paraffined and manufactured from well seasoned lumber. Green lumber aids mould growth.

During packing, keep the butter boxes as dry as possible on the outside.

5. Store all salt in a dry, clean place. When a barrel of salt is opened, have a suitable cover to keep out dust and dirt.

6. Pure wash water should be used. If any doubt exists as to its purity, samples should be submitted regularly for test to the bacteriological laboratory of the provincial university or college. When water storage tanks are used, they should be drained out and thoroughly cleaned at frequent intervals.

When it is necessary to cool the water for washing the butter, it should be cooled in a vat by running ice water or brine through the coil rather than adding the ice directly to the wash water. Serious recontamination may result from ice taken from an impure water supply.

7. Give careful attention to manufacturing methods. The butter should be washed thoroughly to remove as much curd of the buttermilk as possible. Moulds use curd as their food, and any excess may encourage their growth. The moisture retained in the butter should be well incorporated. Leaky butter, or an excess of free moisture assists greatly in mould development. In packing butter, be sure no pockets are left between the butter and the sides of the box to collect moisture or retain air. Butter should be stored in a cold, dry room, at a temperature below 40° F., the colder the better. The storage room should be ventilated.

8. Keep refrigerators clean, dry and free from mould growth. (See under Creamery Refrigerators.)

9. The creamery should have plenty of light and be well ventilated. The interior of the working rooms should be painted throughout yearly at least. Damp walls and ceilings are favourable to mould growth. Outside surroundings should be kept clean. Do not allow rubbish and decaying wood to gather. Moulds grow quickly on such material, and the spores are easily spread about the interior of the creamery by air currents.

10. Systematic mould and yeast counts should be used as an aid in controlling mould in butter, as they furnish information regarding efficiency of pasteurization and the extent of recontamination from the equipment.

11. Strict attention to detail in cleanliness in all factory operations is not only essential to the control of mould, but is, as well, a factor in quality.

12. It should be remembered that butter is a perishable food product, subject to easy contamination by yeasts, moulds and undesirable bacteria, and should be handled as such through every operation.

## Summary

*The creameryman must realize that the successful prevention of mould in butter depends on his ability to keep it out of the product during the manufacturing process after efficient pasteurization, by strict daily attention to thorough sterilization of equipment and general cleanliness.*

## Ackowledgments

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## PUBLICATIONS ON DAIRYING

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